# The N400 in Exact and Approximate Mental Arithmetic

**Eric C. Anderson (ecanderson@hampshire.edu)**
School of Cognitive Science, Hampshire College
893 West St., Amherst, MA 01002 USA

**Joanna Morris Florack (jmorris@hampshire.edu)**
School of Cognitive Science, Hampshire College
893 West St., Amherst, MA 01002 USA

## Introduction

Recent evidence suggests that people may rely on different mental representations and brain regions when completing certain number processing/tasks (Dehaene Spelke, Pinel, Stanescu, and Tsivkin 1999). For example, solving arithmetic problems that require exact calculation is thought to rely on verbal processing while approximate calculation is thought to rely on visuo-spatial processing.

Event-related potential research has shown that when participants are presented with multiplication problems followed by incongruent possible answers, an N400 component is generated similar to those elicited in language paradigms when subjects are presented with sentences ending with semantically inappropriate words (Niedeggen, Rosler, and Jost, 1999).

This study was designed to combine these two areas of research by trying to elicit an N400 in both exact and approximate addition tasks. If exact arithmetic relies on verbal pathways, it makes sense that a linguistic-like N400 could be generated. However if approximate arithmetic relies on different visio-spatial pathways, it seems likely that approximate addition would not generate an N400.

## Methods

Two different mental arithmetic tasks were used to trigger exact and approximate calculation. Addition problems were presented in either Arabic digit (exact condition) or dot quantity (approximate condition) format. A 32 channel NeuroScan cap was used to gather ERP from ten participants who were asked to verify possible solutions that were either correct, incorrect but close to the actual answer, and incorrect and far from the actual answer. For instance, 7 + 9 = 16 would be a correct answer; 7 + 9 = 14 would be a near incorrect answer, and 7 + 9 = 24 would be a far incorrect answer. Each condition used the same problem set of 42 simple addition problems. Problems were presented on a computer running SuperLab. Timing of stimulus presentation was adapted from Niedeggen et. al (1999).

## Results

The ERP data was epoched, baseline corrected, artifact rejected, and averaged for each subject for each electrode in each condition before being analyzed. To test for an N400 effect, the mean voltage amplitude was calculated for the 375-425 ms time window after the possible answer was presented. A three-way ANOVA revealed significant negativity after both foils (near and far) in exact addition but not to foils in approximate addition.

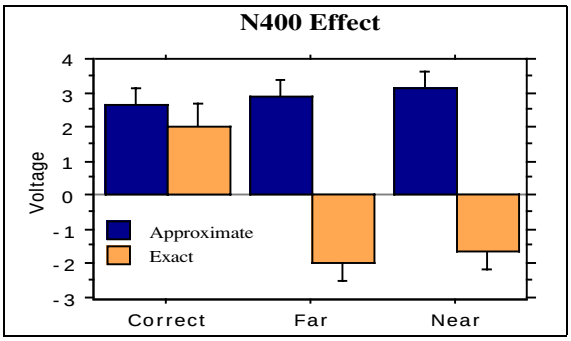


Figure 1: Mean amplitude from 375 to 425 ms.

## Discussion

As expected, incongruous exact addition problems produced an N400 component similar to N400s observed in linguistic paradigms (figure 1). However, the approximate addition task did not show the same pattern of negativity. These results suggest that exact and approximate addition tasks were represented and or processed in different ways. The presence of an N400 also suggests that solving exact addition problems shares certain properties with language processing that approximate addition does not.

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## References

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